

1/72

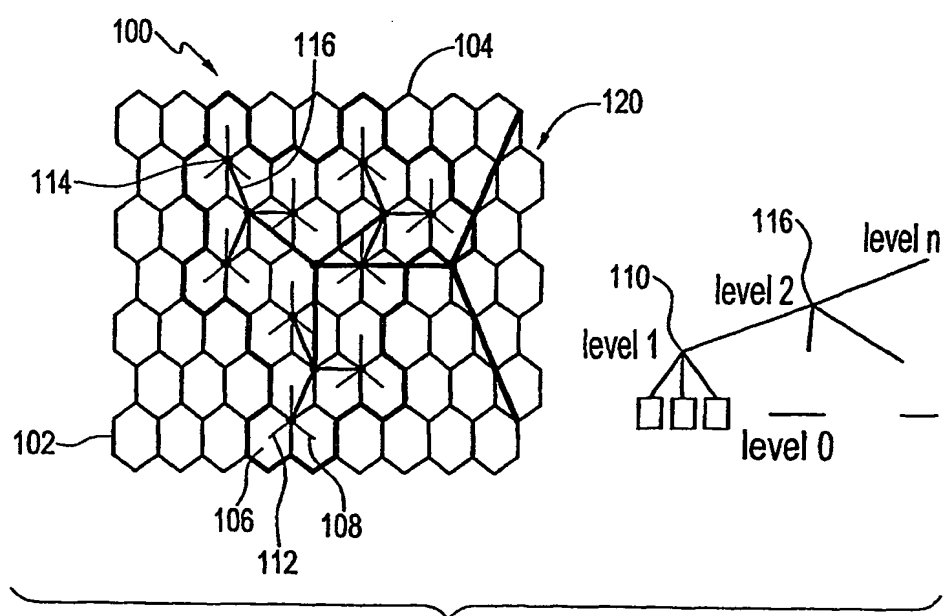
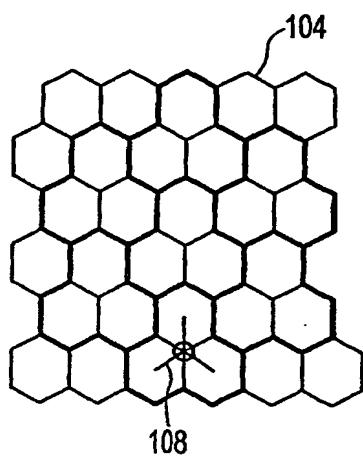


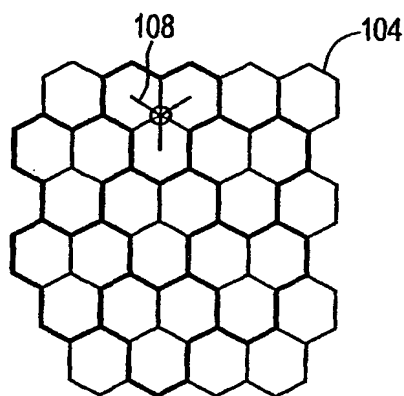
FIG. 1

2/72



(a) ∇ Type

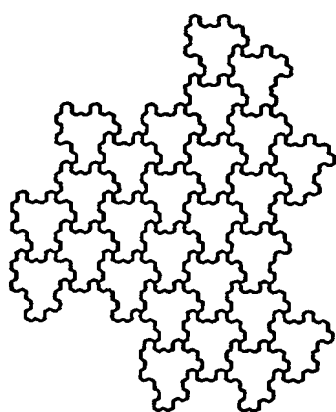
FIG. 2A



(b) ∇ Type

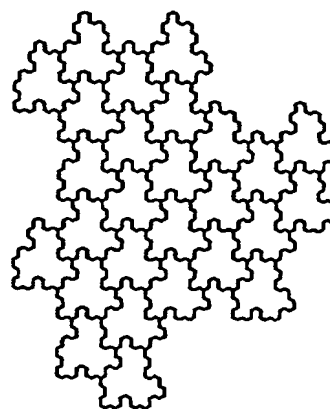
FIG. 2B

3/72



人 > 丫 > 人 <
(a)

FIG. 3A



人 > 人 < 丫 >
(b)

FIG. 3B

4/72

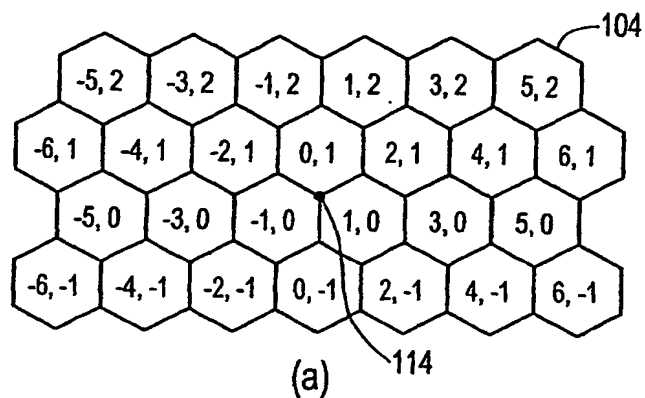


FIG. 4A

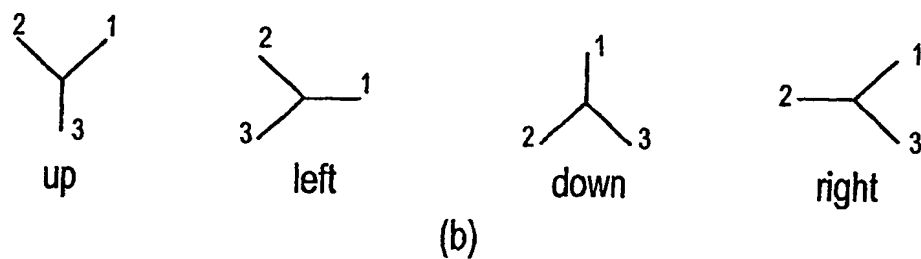


FIG. 4B

5/72

```

Setup_Y_tree(C)
{
  sub-tree1 = Create_leaf(0,1);
  sub tree2 = Create_leaf(-1,0);
  sub-tree3 = Create_leaf(1,0);
  Tree=Compose_tree(sub-tree1,sub-tree2,
    sub-tree3,C(1));
  z = 2/3; x = 1, y = 1/3;
  for i=2:n
  {
    if (i is even)
      { z = z * 3; y = y * 3; }
    else
      x = x * 3;

    case C(i)
      "up":
        { x1= x; x2= -x; x3= 0;
          y1= y; y2= y; y3= -z; }
      "left":
        { x1= z; x2= -x; x3= -x;
          y1= 0; y2= y; y3= -y; }
      "down":
        { x1= 0; x2= -x; x3= x;
          y1= z; y2= -y; y3= -y; }
      "right":
        { x1= x; x2= -z; x3= x;
          y1= y; y2= 0; y3= -y; }

    Copy(sub-tree1,Tree);
    Copy(sub-tree2,Tree);
    Copy(sub-tree3,Tree);
    /* Copy Tree to sub-trees */
    Shift(sub-tree1, x1, y1);

```

FIG. 5A

6/72

```
    Shift(sub-tree2, x2, y2);
    Shift(sub-tree3, x3, y3);
    /* Shift the coordinates of every leaf in
       Tree by x(k) and y(k) respectively */
    Tree=Compose_tree(sub-tree1,sub-tree2,
                      sub-tree3,C(i));
  }
}

Create_leaf(x,y)
{
    Create_tree_node(leaf);
    leaf->x = x;
    leaf->y = y;
    return(leaf);
}

Compose_tree(sub-tree1,sub-tree2,sub-tree3,
             orientation)
{
    Create_tree_node(new_root);
    new_root -> child1 = sub-tree1;
    new_root -> child2 = sub-tree2;
    new_root -> child3 = sub-tree3;
    new_root -> orientation = orientation;
    return(new_root);
}
```

FIG. 5B

7/72

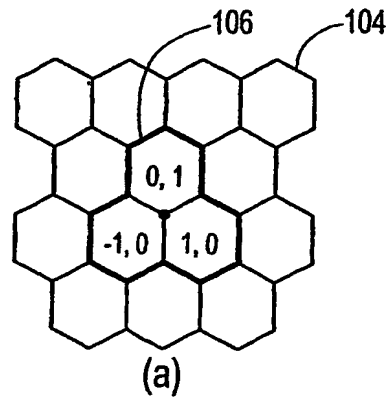


FIG. 6A

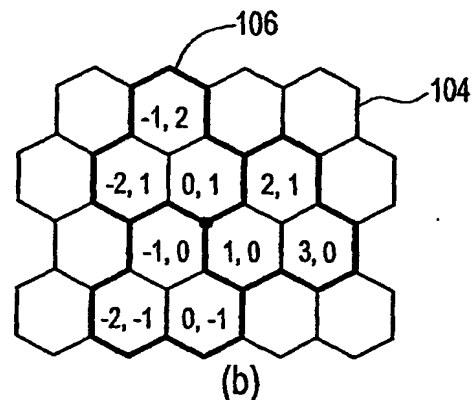


FIG. 6B

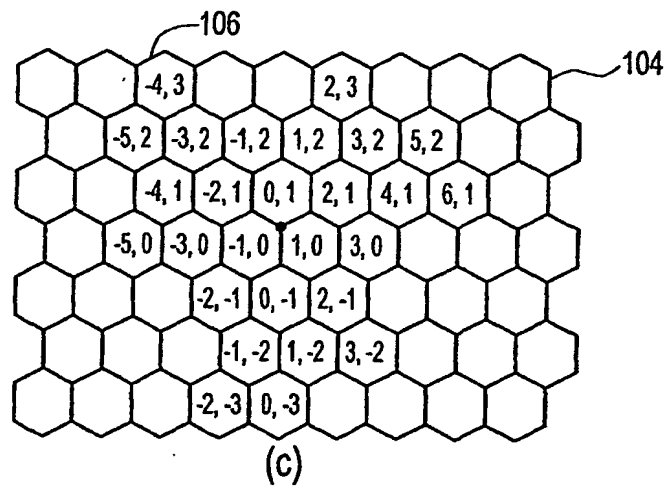


FIG. 6C

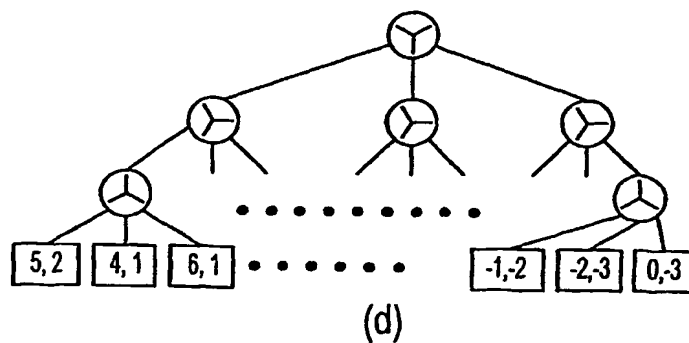


FIG. 6D

8/72

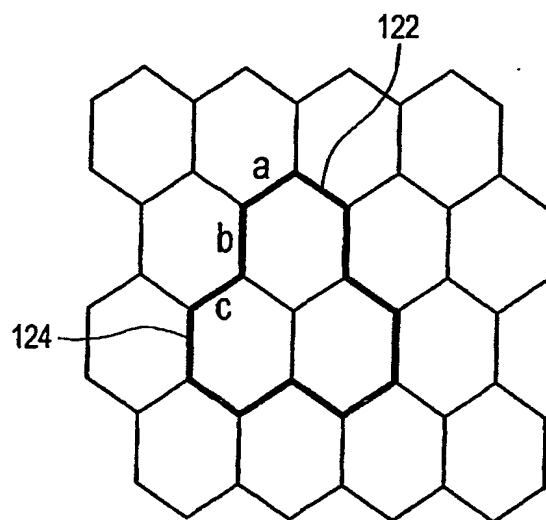


FIG. 7

9/72

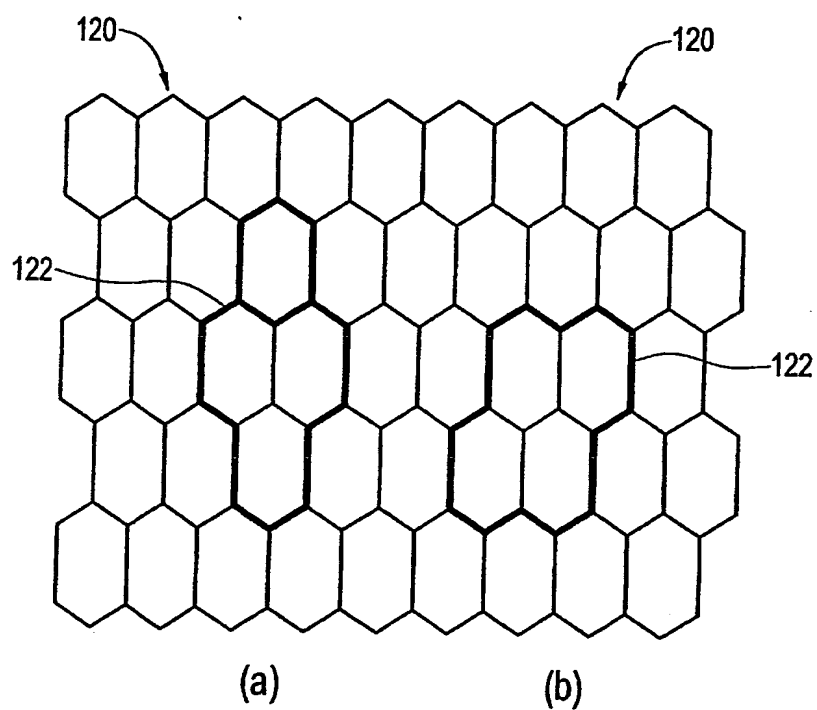


FIG. 8

10/72

```

Merge(A,B)
{
    /* Complement every bit in sequence B */
    BI = Bit_wise_complement(B);
    Bh = Reverse_bit_order(BI);
    do
    {
        /* Find the sub-sequences in A and Bh such
           that the two sub-sequences have the same
           pattern */
        if(Find_next_match(A,Bh,&sub) == false);
        break;

        /* Judge if the result satisfies the
           requirements */
        if(Accept(A,Bh,sub == true)
        {
            /* Rewrite sequence A and B */
            Rewrite sequence A = (A1)(sub)(A2);
            Rewrite sequence B = (B1)RevFlip(sub)(B2);

            /* Determine the sequences A12 and B12, which
               are the portions of A and B in the merged
               polygon C, respectively */
            Calculate A12 = ModMerge(A1, A2);
            Calculate B12 = ModMerge(B1, B2);

            /* Merge A12 and B12 and get C */
            C = (A12)(B12);
            Output(C);
        }
    }
}

RevFlip(Sub)
{
    /* Sub1 is the bit-wise complement of sequence Sub */
    Sub1 = Bit_wise_complement(Sub);
    /* Sub2 is the sequence of reversing the bit order
       of Sub1 */
    Sub2 = Reverse_bit_order(Sub1);
    Return Sub2;
}

ModMerge(S1, S2)
{
    /* S3 is the sequence of S2 followed by S1 */
    S3 = (S2)(S1);
    S4 = Complement_the_first_bit(S3);
    S5 = Delete_the_last_bit(S4);
    Return S5;
}

```

FIG. 9

11/72

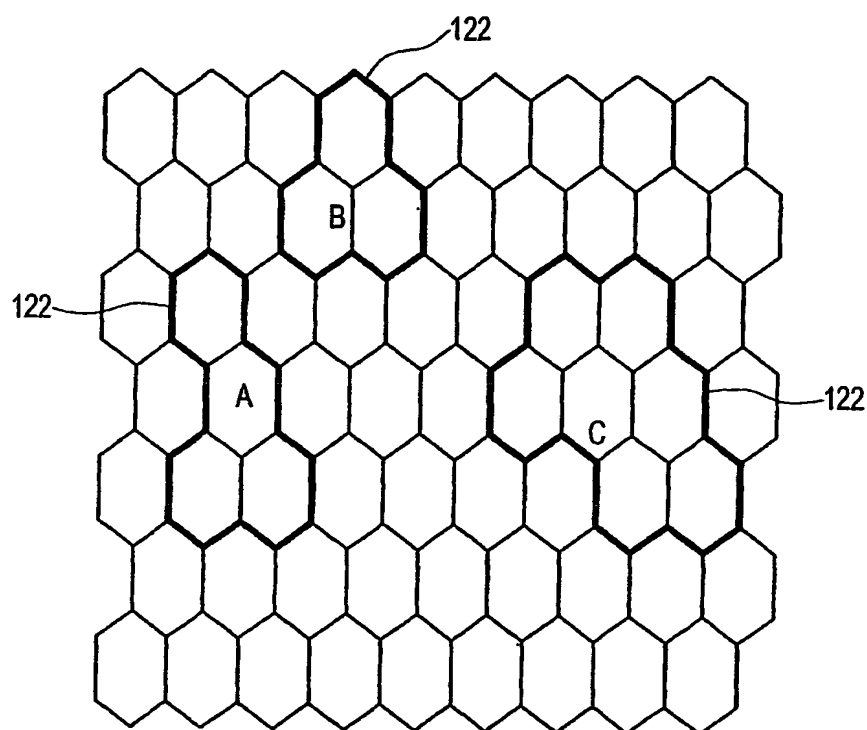


FIG. 10

12/72

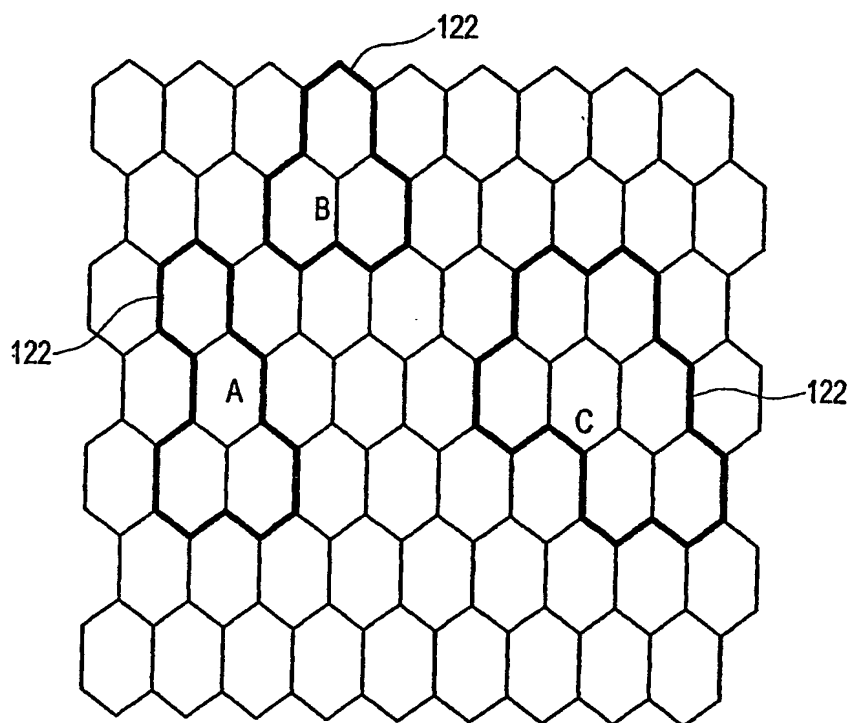


FIG. 11

13/72

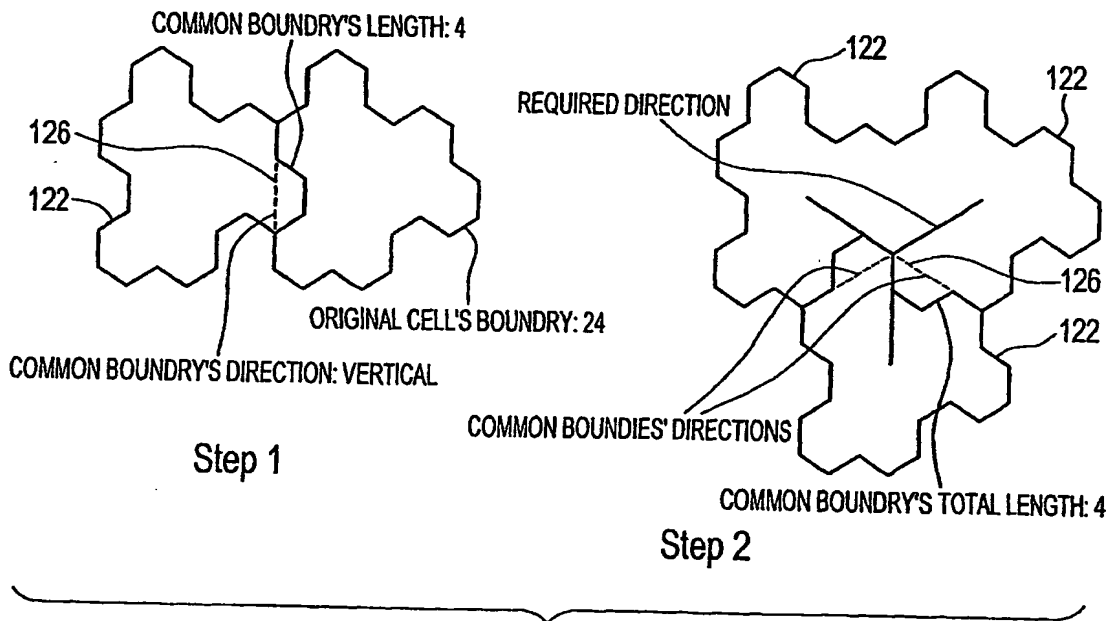
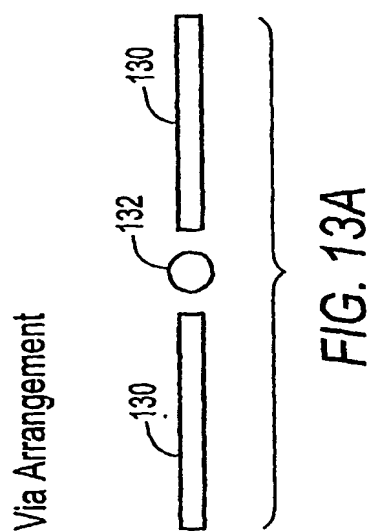
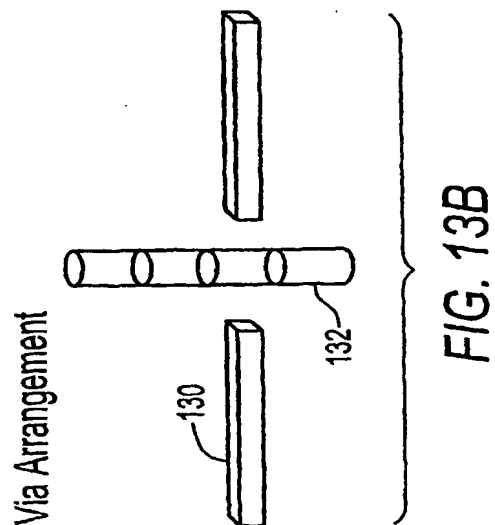


FIG. 12

14/72



15/72

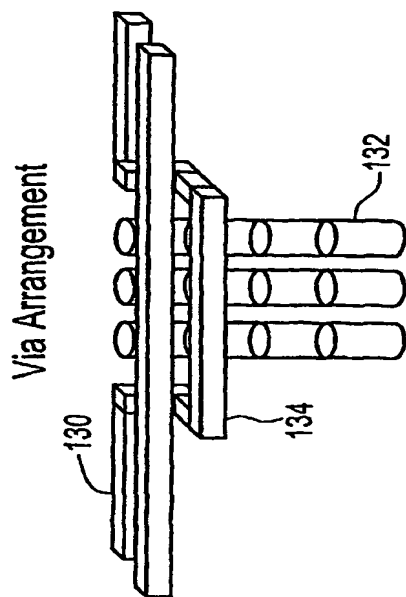


FIG. 14B

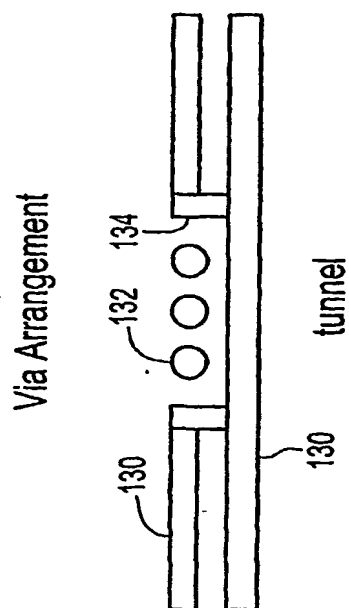


FIG. 14A

16/72

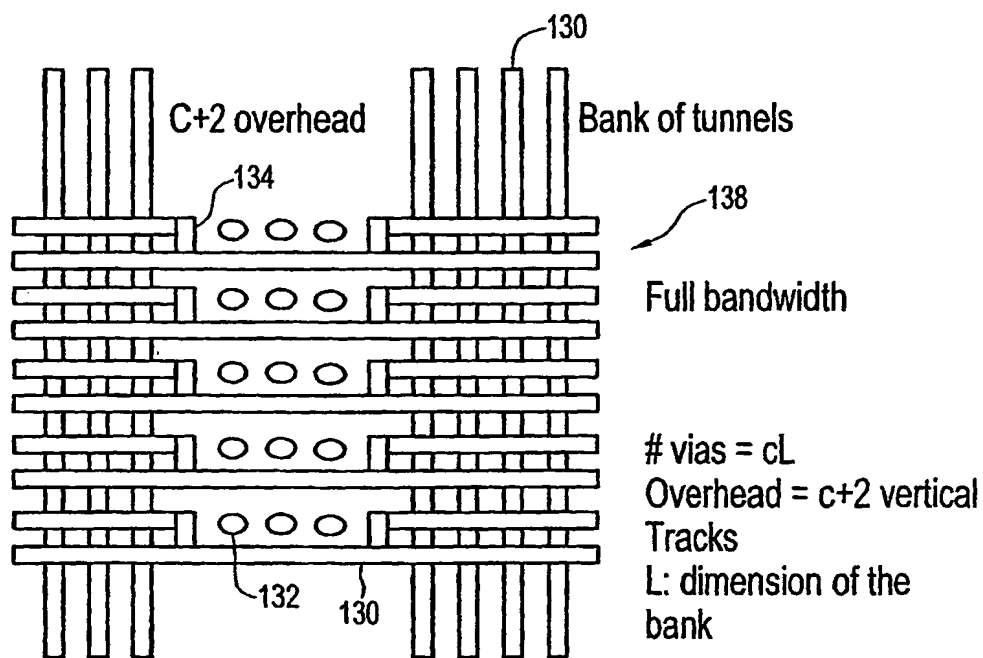
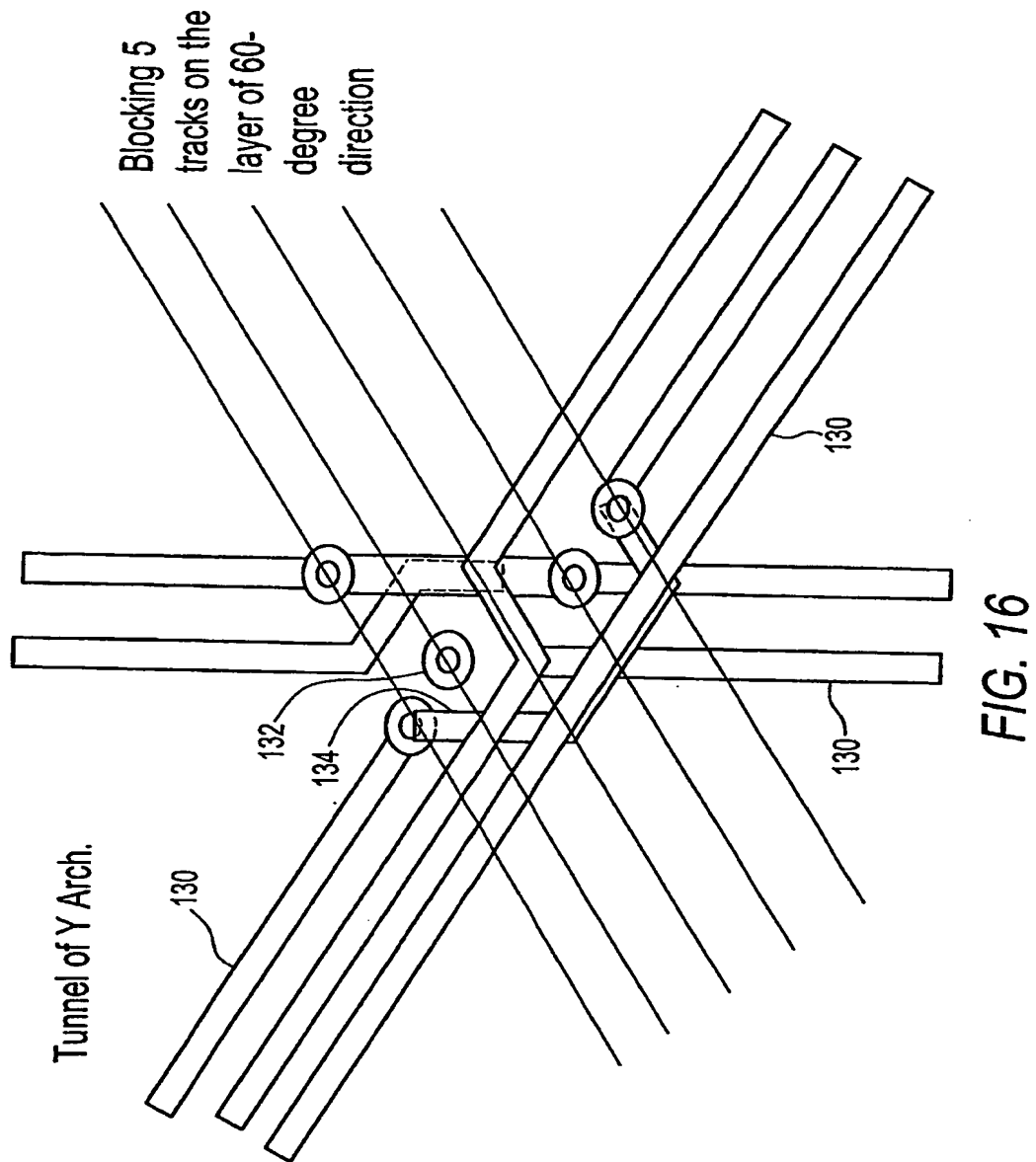


FIG. 15

17/72



18/72

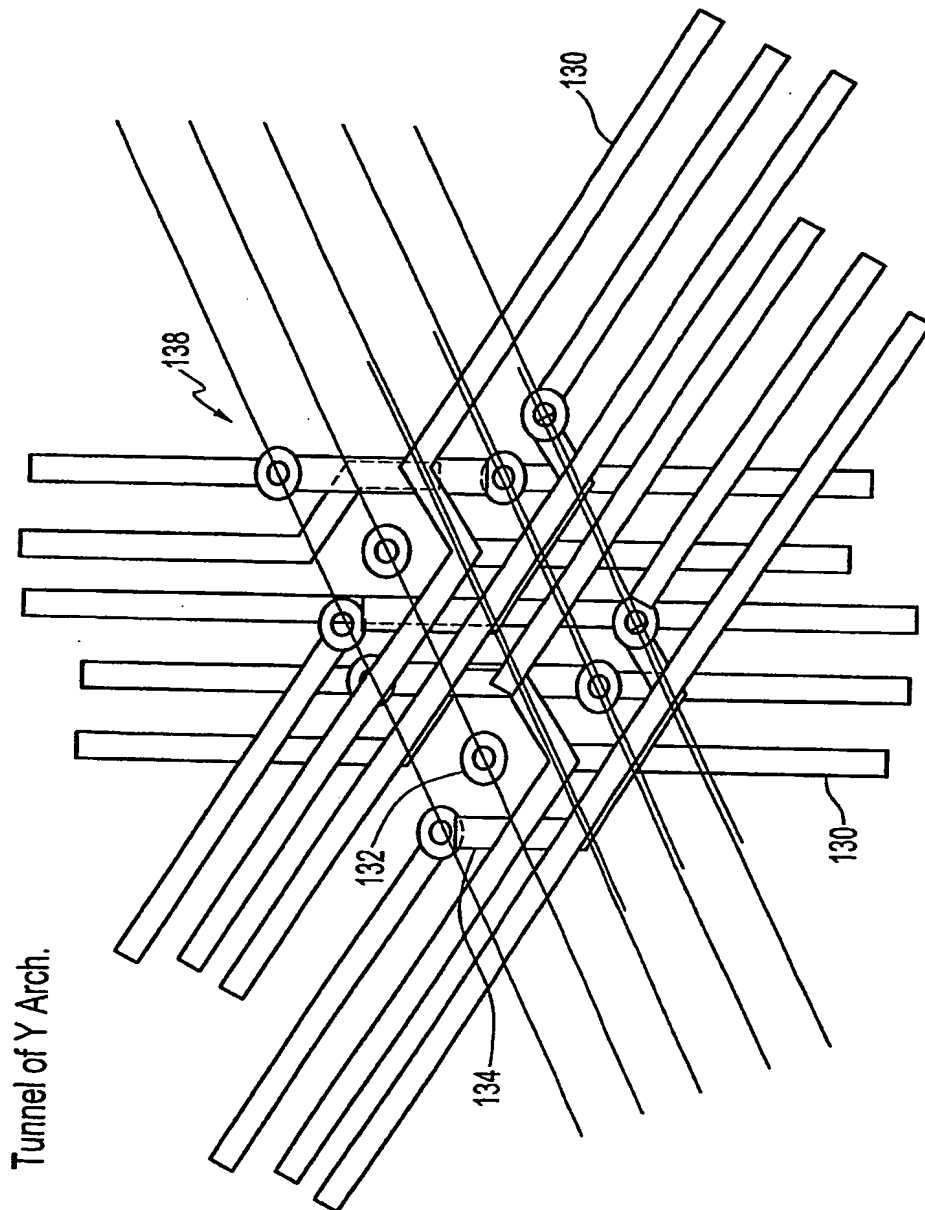


FIG. 17

Tunnel of Y Arch.

19/72

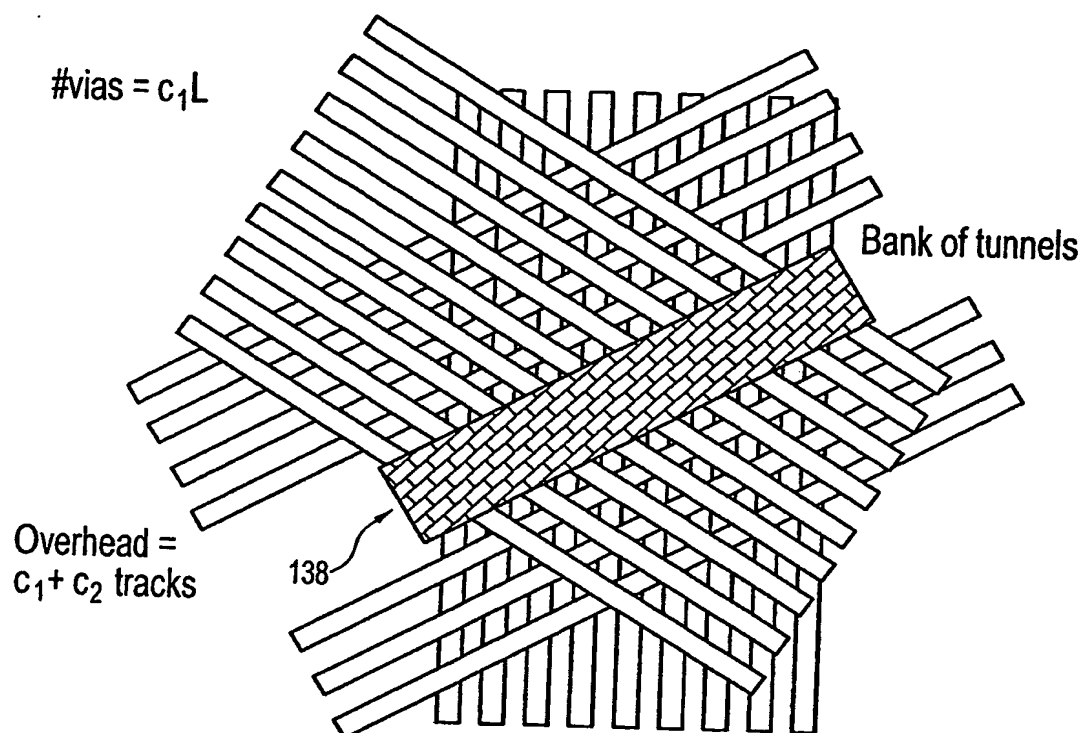


FIG. 18

20/72)

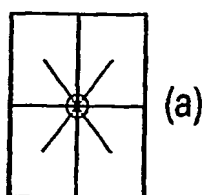


FIG. 19A

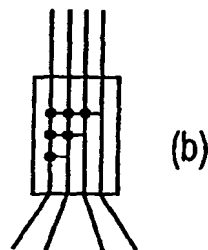
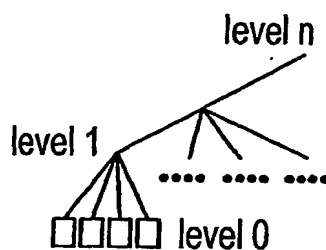
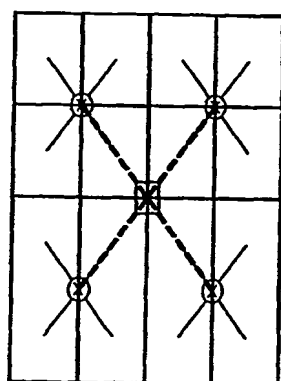


FIG. 19B



(c)

FIG. 19C

21/72

L_x	D_x
$L_1 = 2\sqrt{2}$ $L_n = 4L_{n-1} + 2^{3n-2} \sqrt{2}$	$D_1 = 6\sqrt{2}$ $D_n = 4D_{n-1} + 6 \cdot 2^{4n-4} \sqrt{2} (2^n - 1)$

FIG. 20

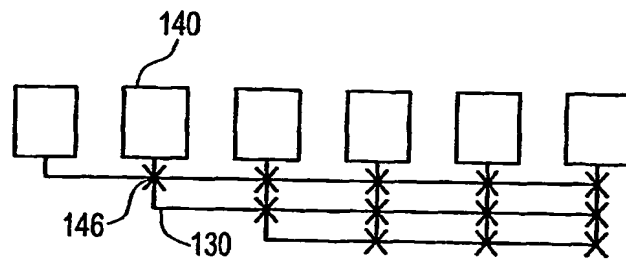
22/72

Recursive form solutions for L_Y and D_Y

L_Y
$L_1 = \sqrt{3} a$ $L_n = 3L_{n-1} + 3^{\frac{3n-1}{2}} a$
D_Y
$D_1 = 2\sqrt{3} a$ $D_n = 3D_{n-1} + (3 + \sqrt{3}) (3^{\frac{n}{2}} - 1) 3^{2n-2} a$

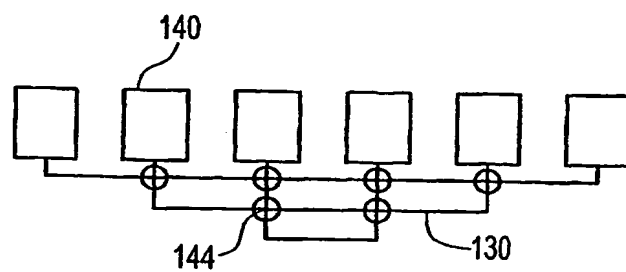
FIG. 21

23/72



(a)

FIG. 22



(b)

FIG. 23

24/72

Model	L	D	M
a	$\frac{3n^2 - 2n}{8}$	$\frac{n(n+1)(n-1)}{6}$	$\frac{n^2(3n-2)(n-1)(n+1)}{48}$
b	$\frac{n^2}{4}$	$\frac{n(n+1)(n-1)}{6}$	$\frac{n^3(n-1)(n+1)}{24}$

FIG. 24

25/72

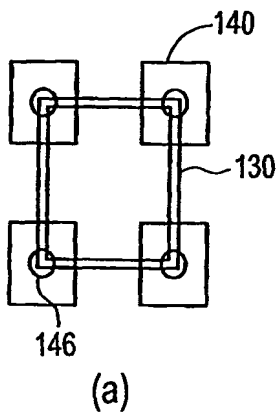


FIG. 25A

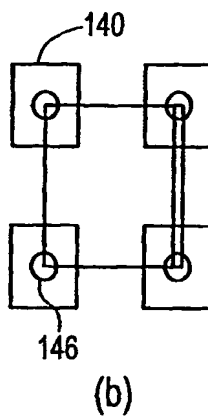


FIG. 25B

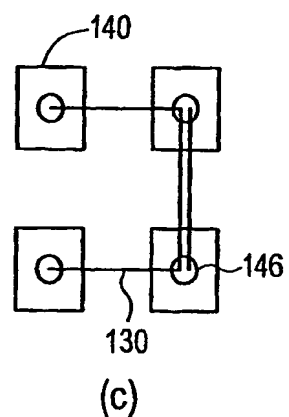


FIG. 25C

26/72

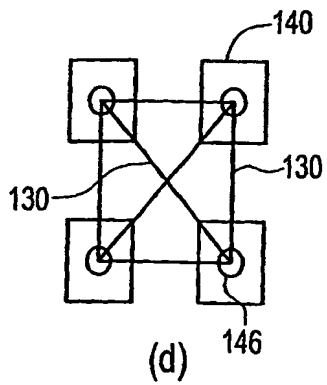


FIG. 25D

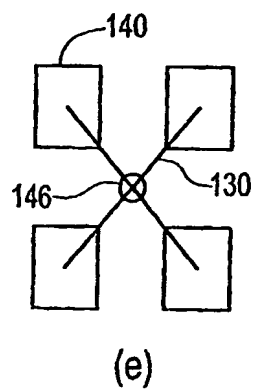


FIG. 25E

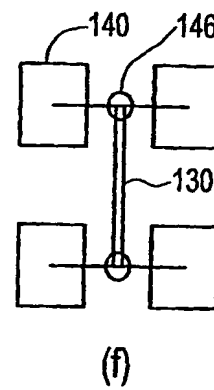


FIG. 25F

27/72

Model	L	D	M
a	8	8	64
b	5	8	40
c	4	10	40
d	$4 + 2\sqrt{2}$	$4 + 2\sqrt{2}$	$24 + 16\sqrt{2}$
e	$2\sqrt{2}$	$6\sqrt{2}$	24
f	4	10	40

FIG. 26

28/72

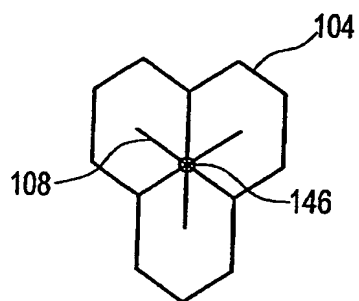


FIG. 27A

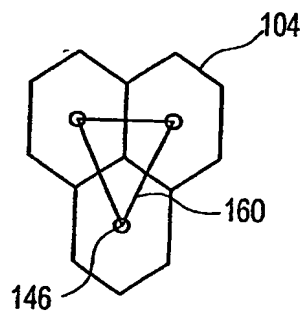


FIG. 27B

29/72

Model	L	D	M
Y	$\sqrt{3}$	$2\sqrt{3}$	6
Δ	3	3	9

FIG. 28

30/72

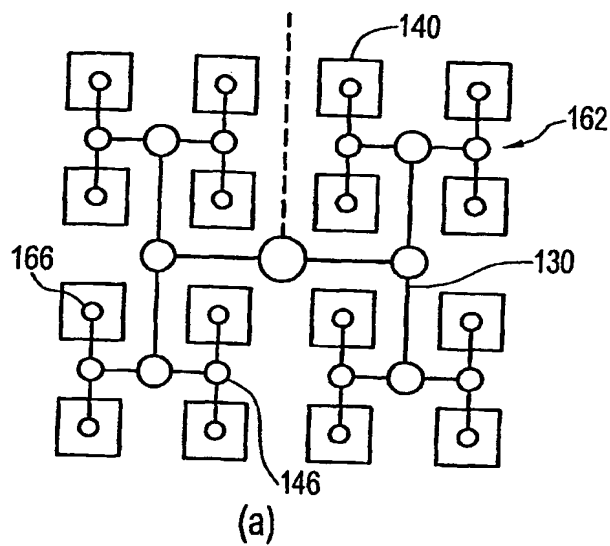


FIG. 29A

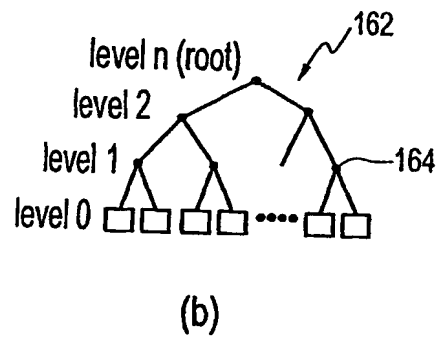


FIG. 29B

31/72

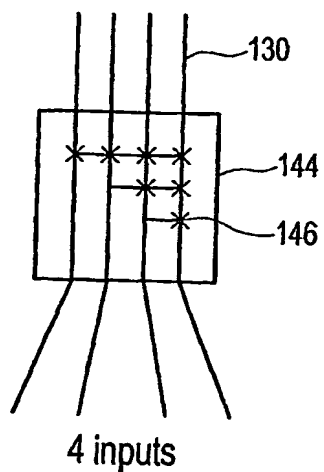


FIG. 30A

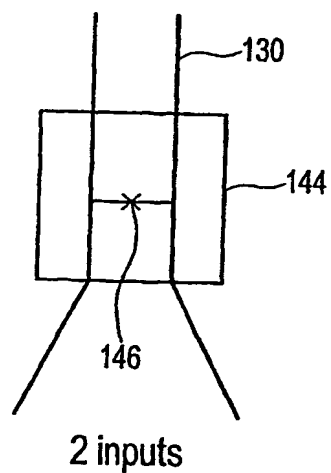


FIG. 30B

32/72

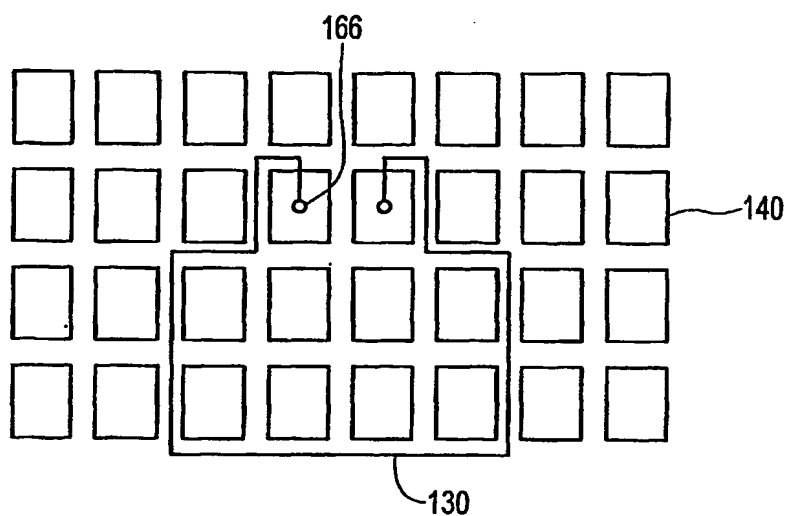
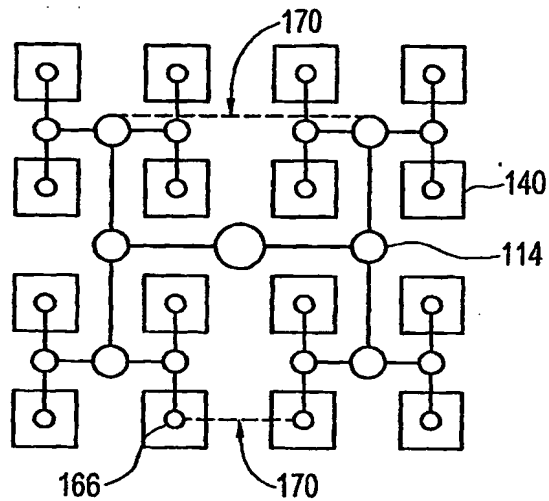


FIG. 31

33/72

possible additional interconnection (level 2)



possible additional interconnection (level 0)

FIG. 32

34/72

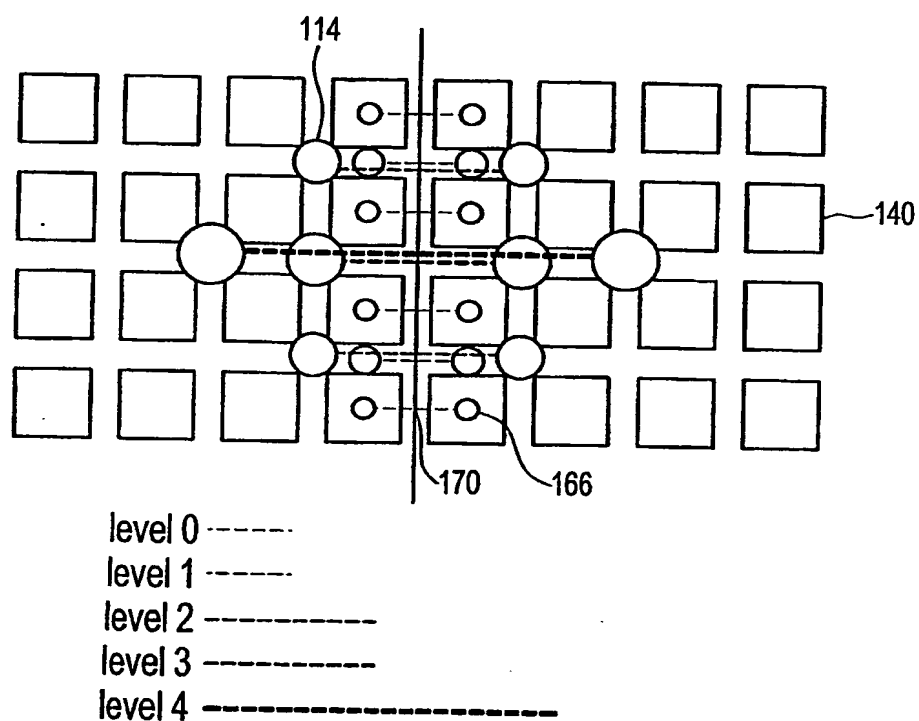


FIG. 33

35/72

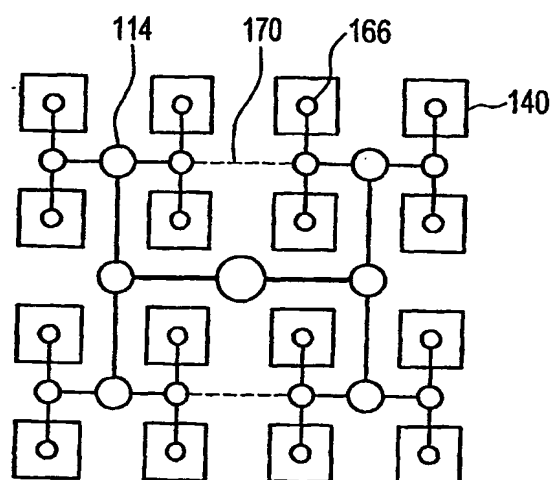


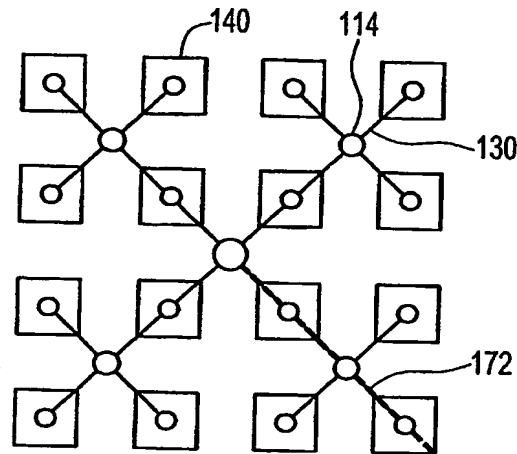
FIG. 34

36/72

m	ΔL	ΔD	I
0	32	-1952	61
1	32	-3840	120
2	128	-14848	116
3	128	-28672	224
4	512	-106496	208
5	512	-196608	384
6	2048	-655360	320
7	2048	-1048576	512
8	8192	-2097152	256

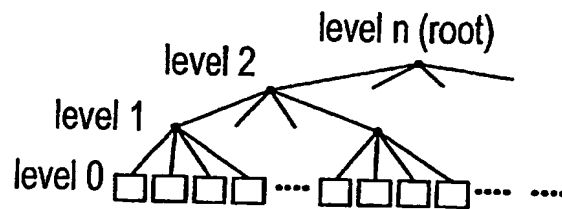
FIG. 35

37/72



(a)

FIG. 36A



(b)

FIG. 36B

38/72

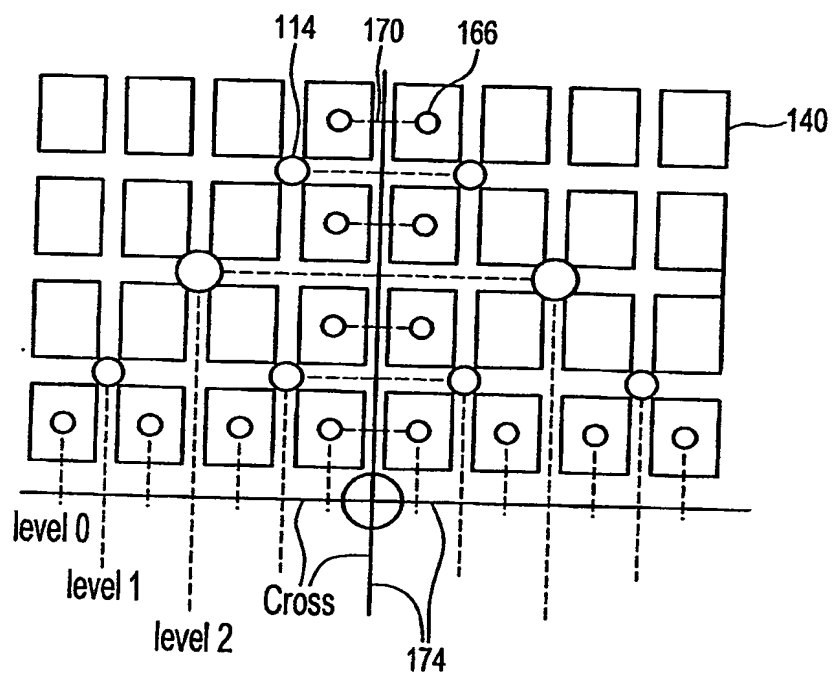


FIG. 37

39/72

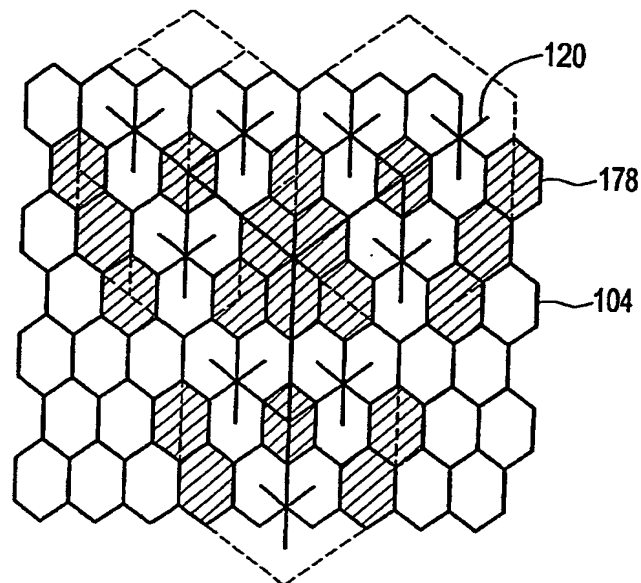


FIG. 38A

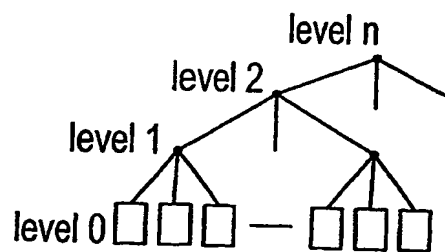
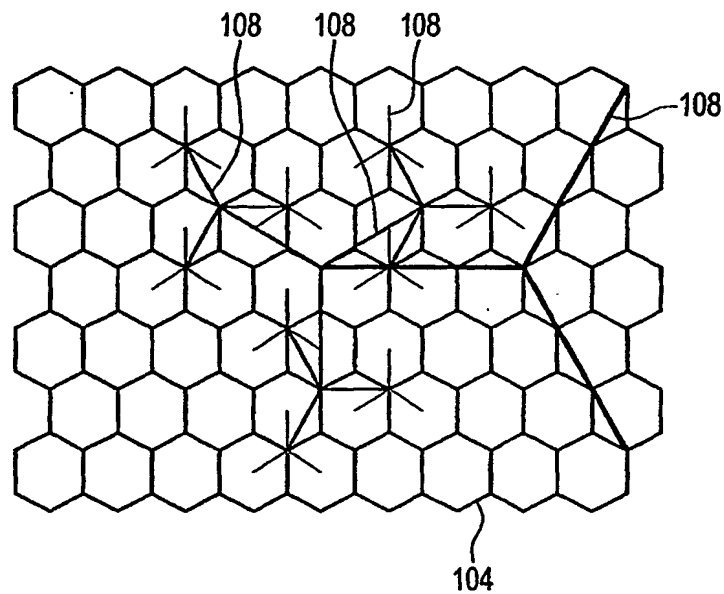


FIG. 38B

40/72

**FIG. 39**

41/72

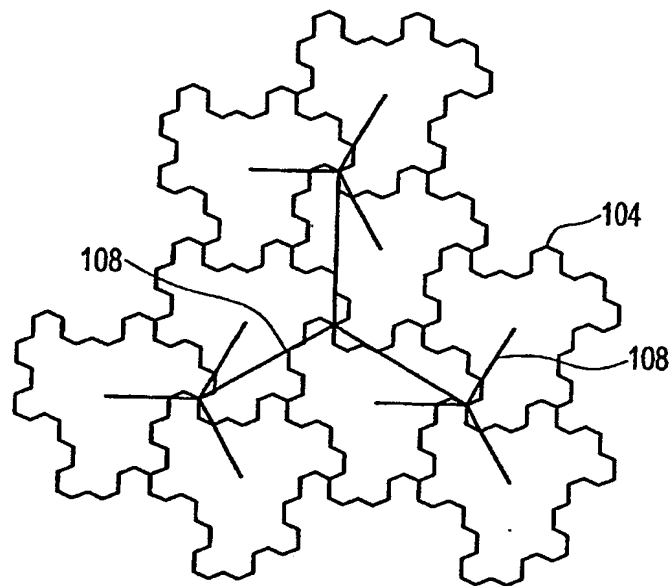


FIG. 40

42/72

Type	L
With dead cells	$L_1 = \sqrt{3}$ $L_n = 3L_{n-1} + 6^{n-1}\sqrt{3}$
Without dead cells	$L_1 = \sqrt{3}$ $L_n = 3L_{n-1} + 3^{n-1}\sqrt{3}^n$

Type	D
With dead cells	$D_1 = 2\sqrt{3}$ $D_n = 3D_{n-1} + 2\sqrt{3}(2^{n-1}-1)9^{n-1}$
Without dead cells	$D_1 = 2\sqrt{3}$ $D_n = 3D_{n-1} + (\sqrt{3}+3)(\sqrt{3}^n-1)9^{n-1}$

FIG. 41

43/72

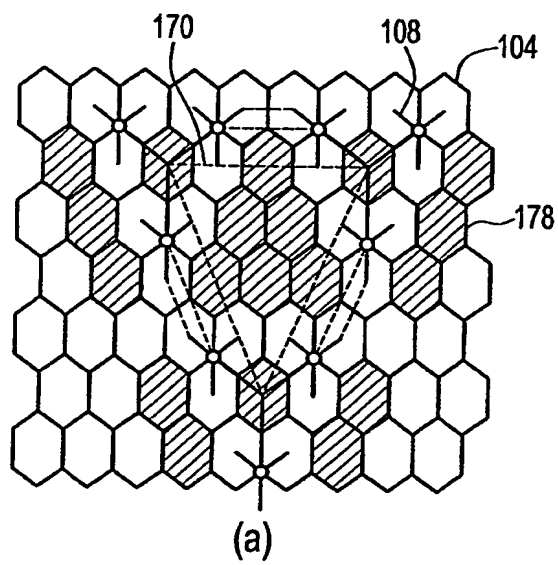


FIG. 42A

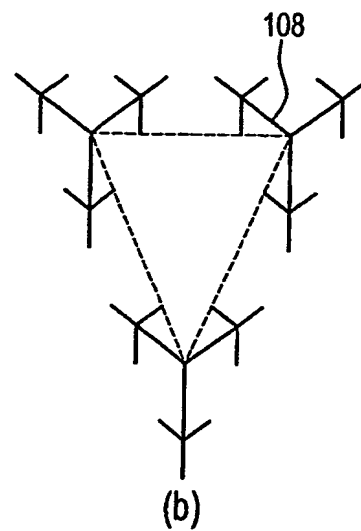


FIG. 42B

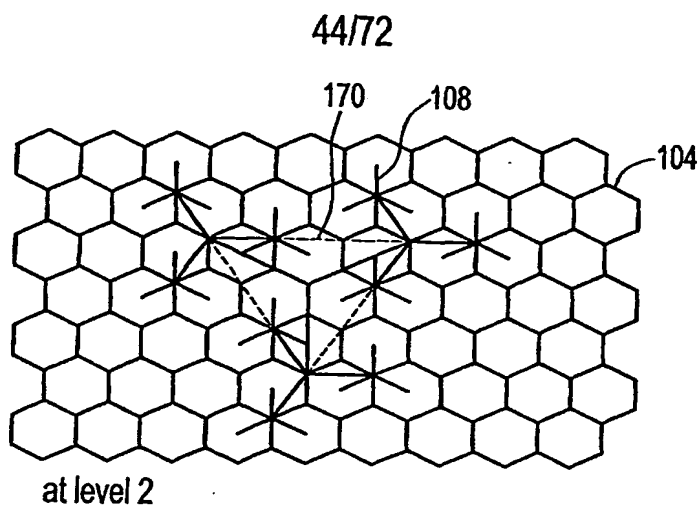


FIG. 43A

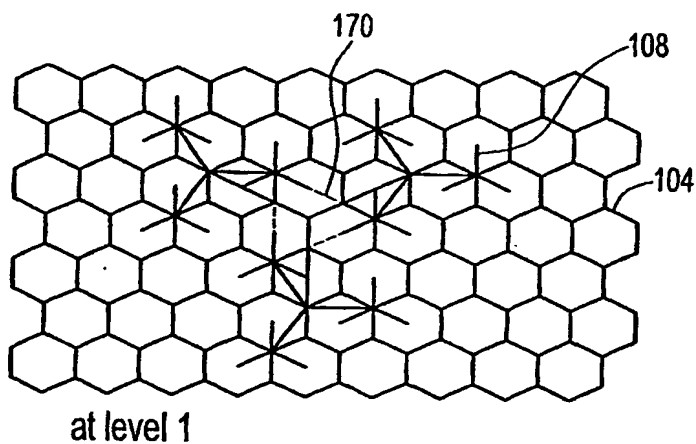


FIG. 43B

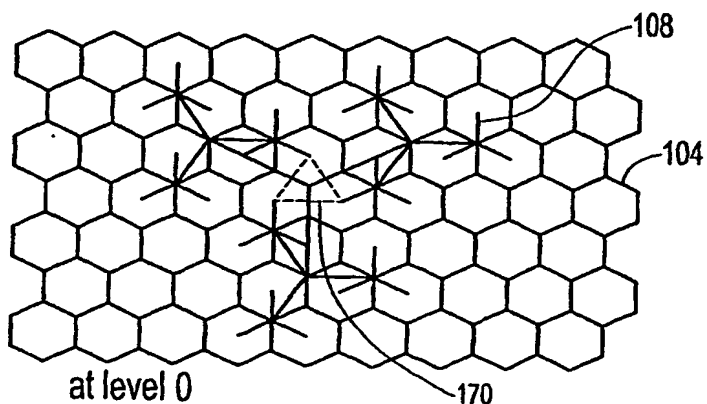


FIG. 43C

SUBSTITUTE SHEET (RULE 26)

45/72

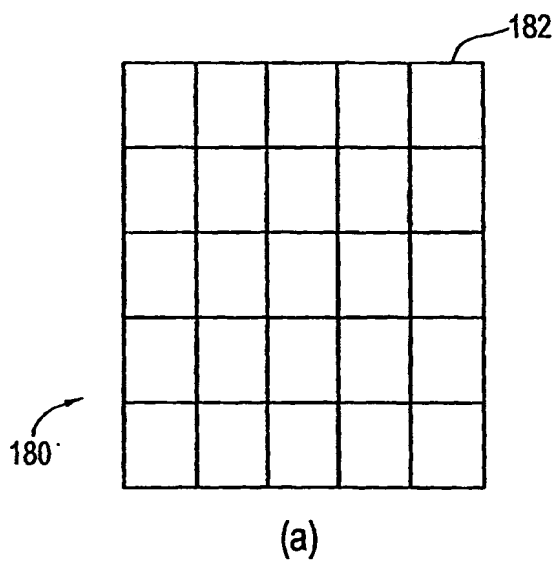


FIG. 44

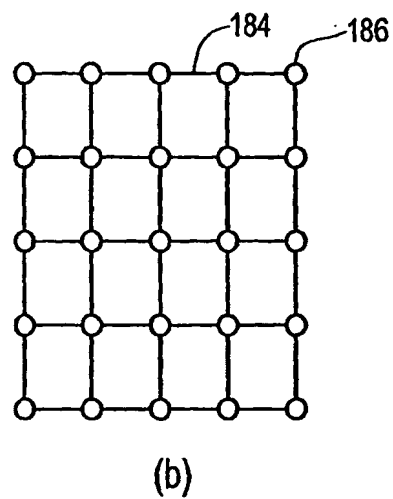
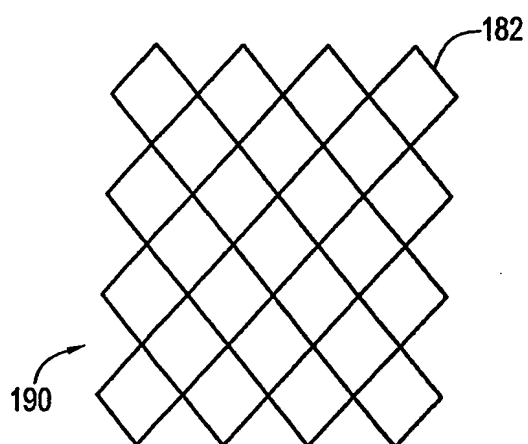


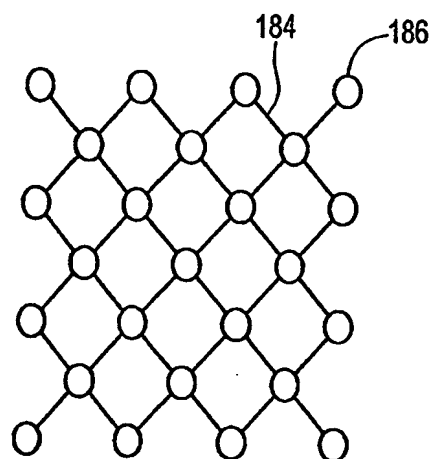
FIG. 45

46/72



(a)

FIG. 46



(b)

FIG. 47

47/72

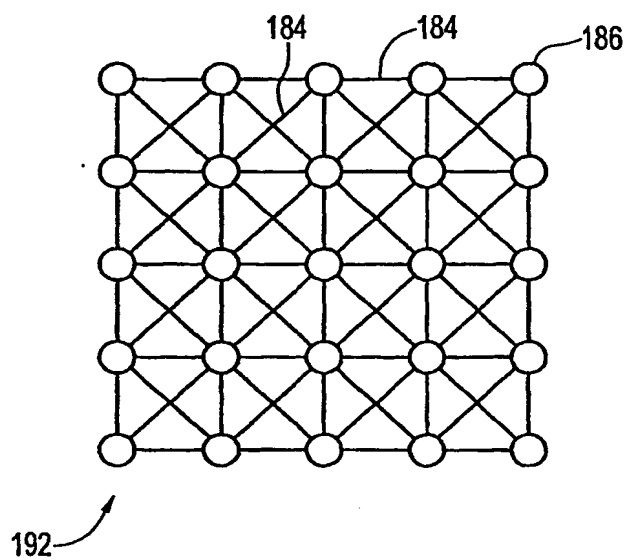


FIG. 48

48/72

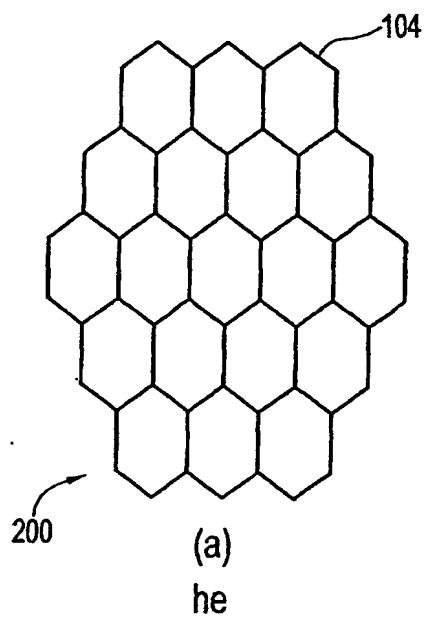


FIG. 49

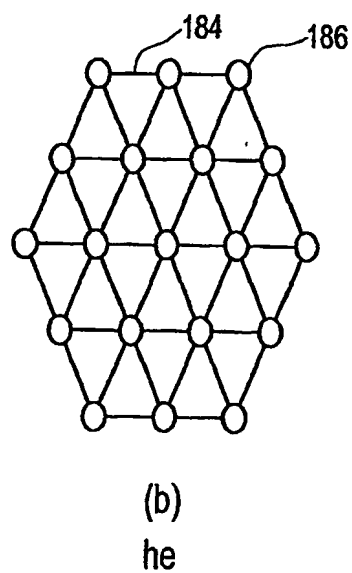


FIG. 50

49/72

```

Algorithm
For all  $e \in E$ , set  $d_e = \text{constant}$ 
Repeat
  For  $j := 1$  to  $k$  do //k: number of distinct flow demands
    Begin
      Set  $d(j) = \sigma$ 
      While  $d(j) \neq 0$  do
        Begin
          Find shortest path  $P$  for commodity flow demand  $j$ .
          Route  $f = \min\{c, d(j)\}$  units of flow along  $P$ , where  $c$  is the capacity of the minimum
            capacity edge on this path.
           $d(j) = d(j) - f$ 
          Update  $\{d_e\}$ .
        End while
      End for
    Find  $\{C_1, C_2, \dots, C_m\}$ , such that  $\sum_{e \in R(i)} d_e = \alpha_i$  and  $\sum_i \alpha_i C_i = 1$ 
    Update  $\{d_e\}$ 
  Until flow solutions converge

```

FIG. 51

50/72

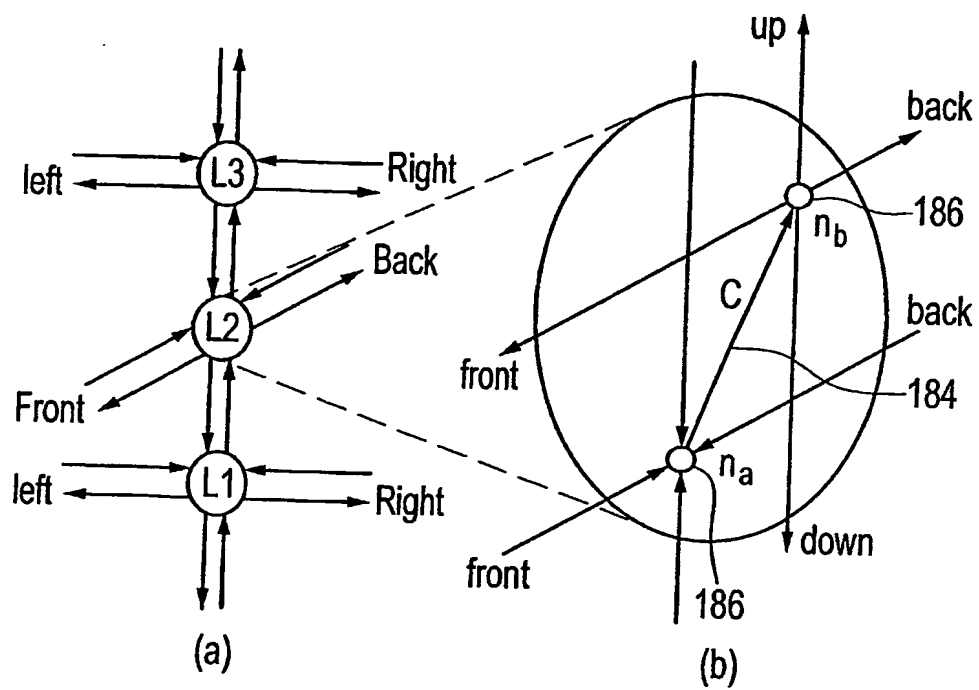
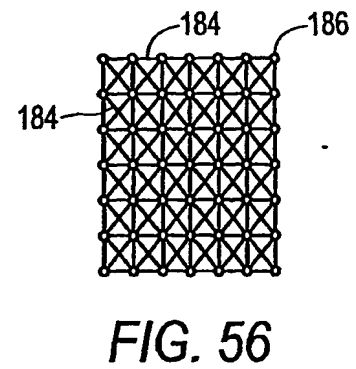
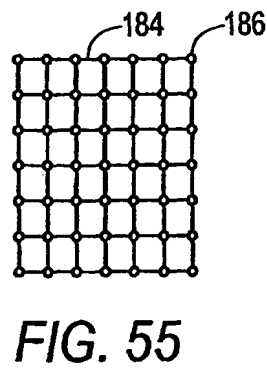
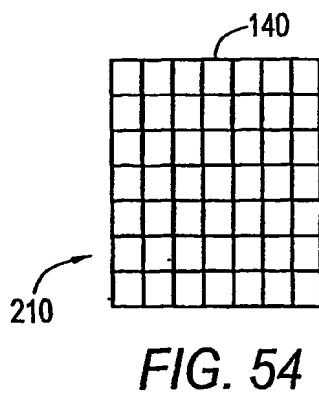
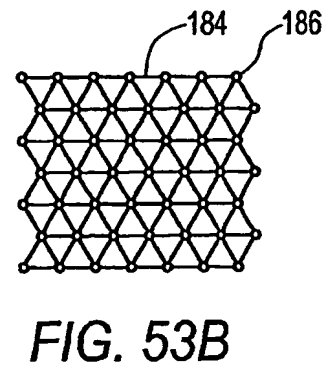
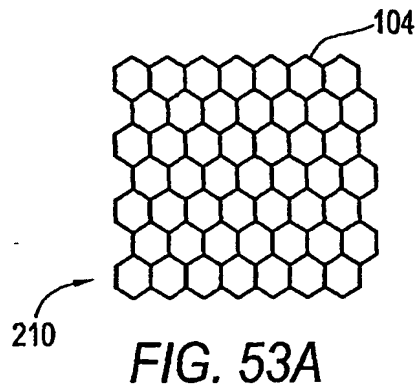


FIG. 52

51/72



52/72

Results of uniform edge capacity mesh

n	Number of nodes	z
2	4	0.3750
3	9	0.3333
4	16	0.2343
5	25	0.2000
6	36	0.1620
7	49	0.1429
8	64	0.1229
9	81	0.1111
10	100	0.0990

FIG. 57

53/72

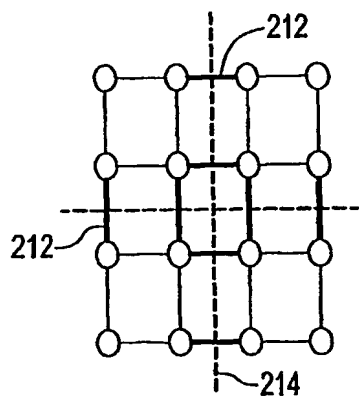


FIG. 58A

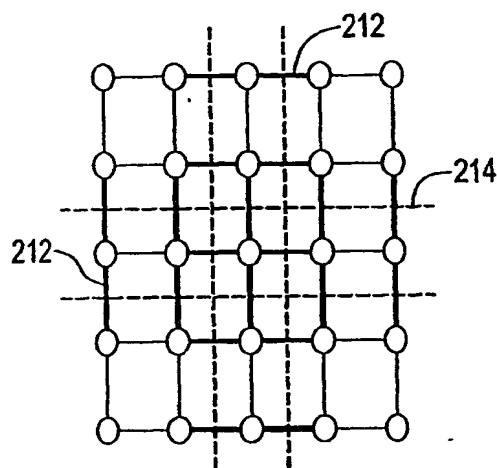


FIG. 58B

54/72

Results of fixed total edge capacities

N	Number of nodes	z	Improvement on z (%)
2	4	0.375	0.00
3	9	0.333	0.00
4	16	0.281	20.01
5	25	0.240	20.00
6	36	0.208	28.57
7	49	0.185	28.56
8	64	0.169	33.32
9	81	0.148	33.35
10	100	0.134	36.36

FIG. 59

55/72

Optimal capacities for vertical edges in 6 by 6 mesh

Col Row	1	2	3	4	5	6	Sum
1	0.60	0.74	0.79	0.79	0.74	0.61	4.28
2	0.95	1.19	1.27	1.28	1.19	0.96	6.85
3	1.07	1.34	1.44	1.44	1.34	1.07	7.71
4	0.95	1.19	1.27	1.27	1.19	0.96	6.85
5	0.60	0.74	0.79	0.79	0.74	0.60	4.28

FIG. 60

56/72

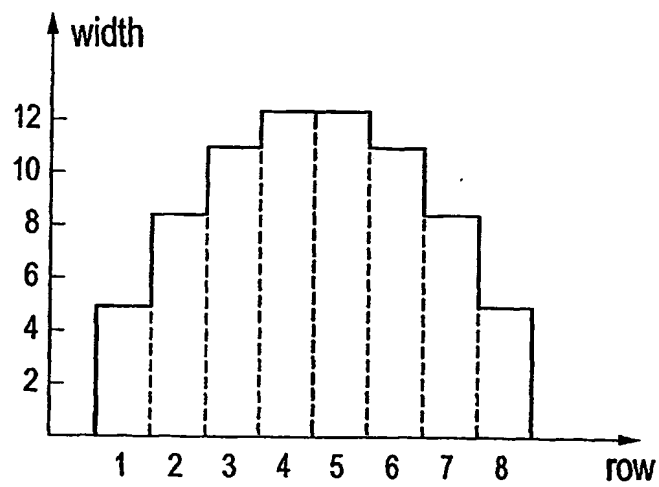


FIG. 61

57/72

Results of 45-degree mesh

N	Number of nodes	z
2	5	0.250
3	13	0.250
4	25	0.209
5	41	0.174
6	61	0.147
7	85	0.126
8	113	0.106
9	145	0.101
10	181	0.0828
11	221	0.0759
12	265	0.0673

FIG. 62

58/72

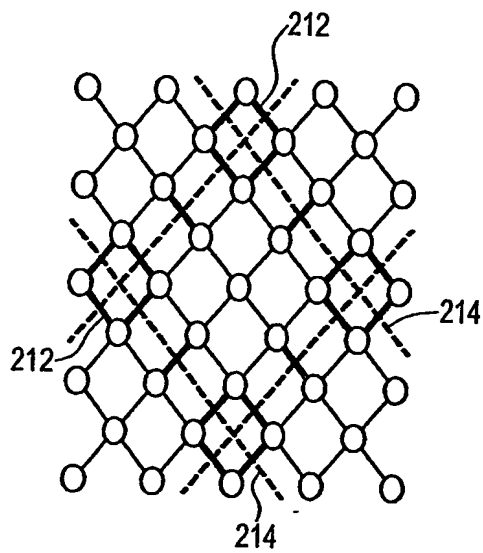


FIG. 63A

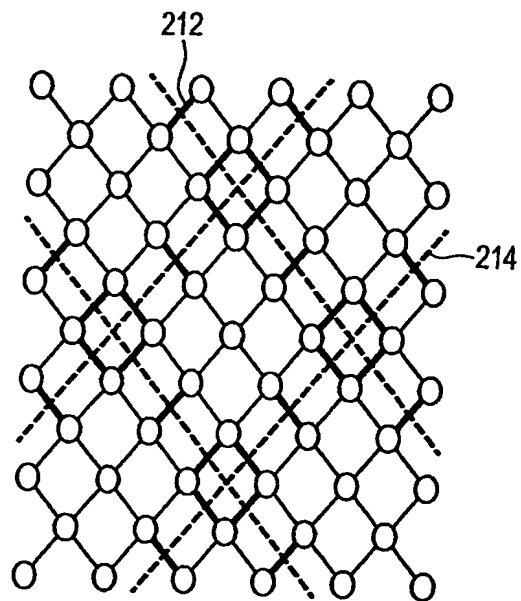


FIG. 63B

59/72

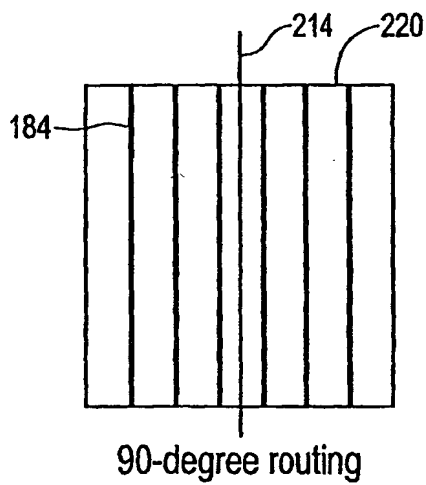


FIG. 64A

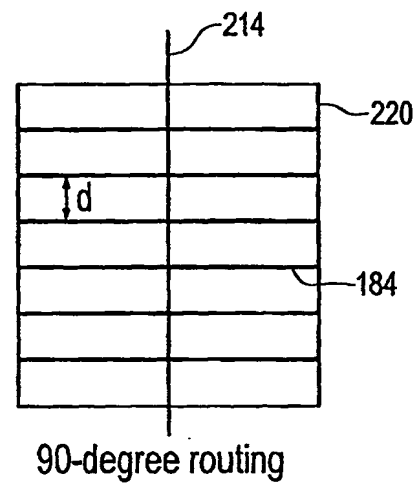
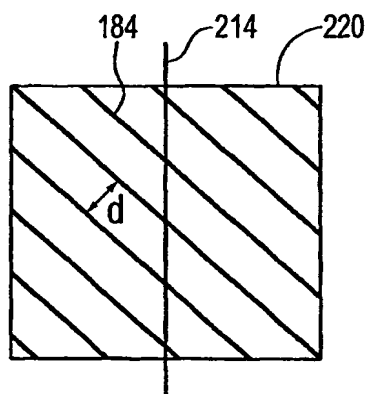


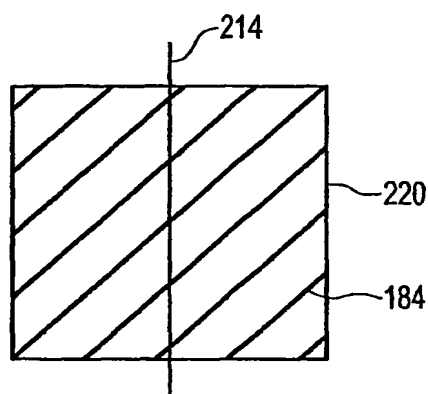
FIG. 64B

60/72



45-degree routing

FIG. 65A



45-degree routing

FIG. 65B

61/72

Results of 90-degree and 45-degree mixed mesh

n	z	Improvement on z (%)	C ₁	C ₂	$\sqrt{2} \cdot C_2 / C_1$
2	0.375	0.00	1.0000	0.0000	0.00
3	0.333	0.00	1.0000	0.0000	0.00
4	0.245	4.85	0.2290	0.5452	3.36
5	0.219	9.53	0.2577	0.5249	2.88
6	0.185	14.04	0.1853	0.5761	4.39
7	0.166	16.01	0.2022	0.5641	3.94
8	0.148	20.11	0.1614	0.5930	5.19
9	0.134	20.40	0.1696	0.5872	4.89
10	0.120	21.31	0.1553	0.5988	5.44
11	0.110	21.48	0.1608	0.5935	5.22
12	0.101	22.05	0.1527	0.5992	5.55
13	0.094	22.14	0.1562	0.5967	5.40
14	0.087	22.68	0.1510	0.6004	5.62
15	0.082	22.71	0.1536	0.5986	5.51
16	0.076	22.95	0.1504	0.6008	5.65
17	0.0723	23.02	0.1524	0.5994	5.56

FIG. 66

62/72

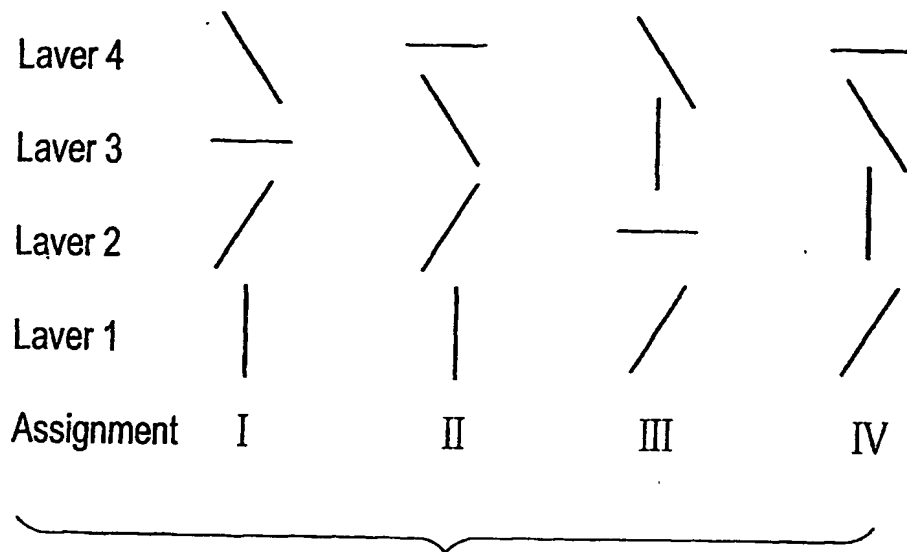


FIG. 67

63/72

N	$z(I)$	$z(II)$	$z(III)$	$z(IV)$
5	0.0173	0.0147	0.0147	0.0171
6	0.0102	0.0083	0.0083	0.0101
7	0.0065	0.0053	0.0051	0.0064
8	0.0041	0.0034	0.0034	0.0041

FIG. 68

64/72

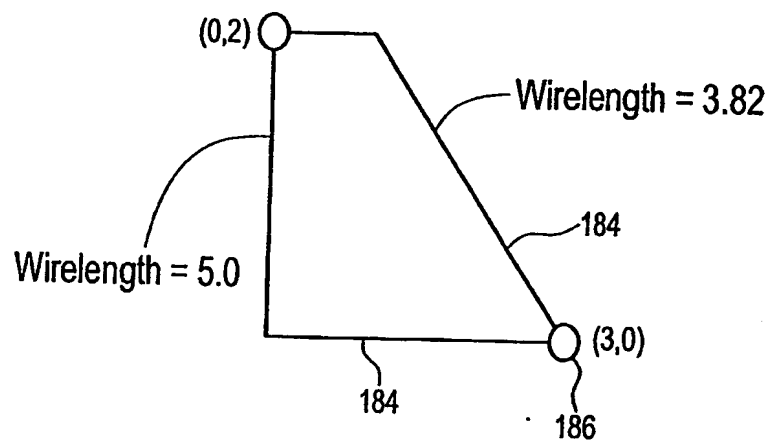


FIG. 69

65/72

n	#nodes	M-architecture		Y-architecture		X-architecture		
		thrpt	n.thrpt	n..thrpt	impr.(%)	n.thrpt	impr. (%)	$\sqrt{2} \cdot C_2/C_1$
2	4	2.50E-1	2.00	2.00	0	2.00	0	0.00
3	9	8.33E-2	2.25	2.25	0	2.25	0	0.00
4	16	3.12E-2	2.00	2.36	18.0	2.60	29.8	3.36
5	25	1.67E-2	2.09	2.40	20.1	2.68	28.1	2.88
6	36	9.26E-3	2.00	2.41	20.4	2.65	32.8	4.39
7	49	5.95E-3	2.04	2.41	20.4	2.67	31.1	3.94
8	64	3.90E-3	2.00	2.38	19.1	2.69	34.6	5.19
9	81	2.78E-3	2.03	2.45	22.5	2.69	32.7	4.89
10	100	1.98E-3	2.00	2.43	21.3	2.67	33.3	5.44
11	121	1.51E-3	2.01	2.46	23.1	2.70	34.4	5.12
12	144	1.16E-3	2.00	2.43	21.4	2.69	34.5	5.26
13	169	9.15E-4	2.01	2.43	21.5	2.70	34.4	5.33
14	196	7.29E-4	2.00	2.43	21.5	2.69	34.5	5.62
15	225	5.95E-4	2.01	2.43	21.6	2.70	34.5	5.51
16	256	4.88E-4	2.00	2.44	22.0	2.69	34.6	5.65
17	289	4.08E-4	2.00	2.45	22.5	2.70	34.6	5.56

FIG. 70

66/72

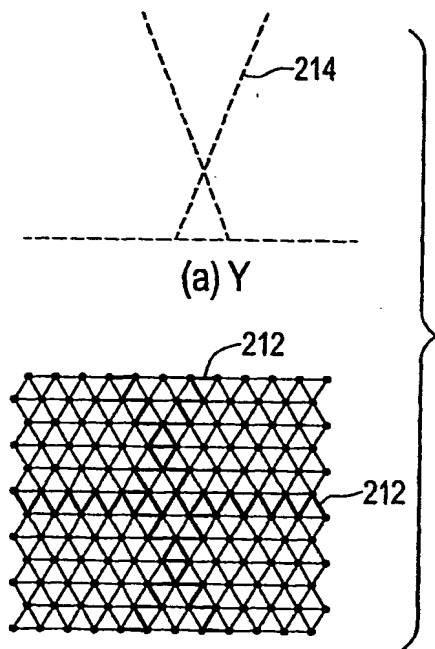


FIG. 71

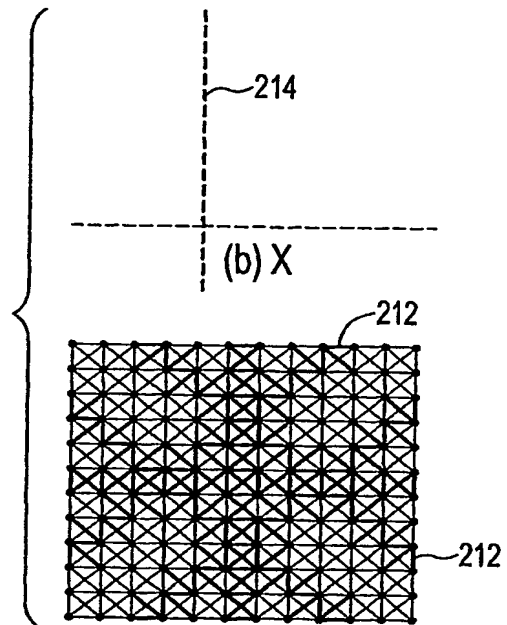


FIG. 72

67/72

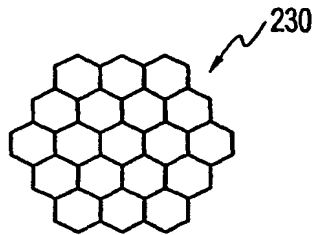


FIG. 73A

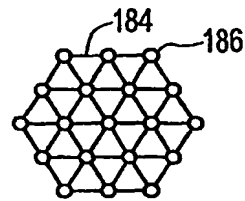


FIG. 73B

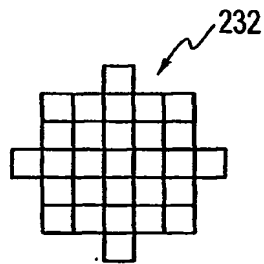


FIG. 73C

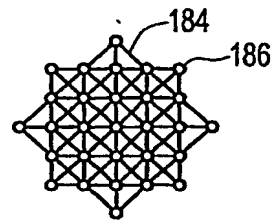


FIG. 73D

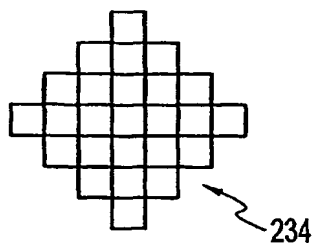


FIG. 73E

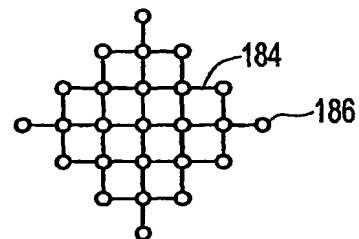


FIG. 73F

68/72

Level	#nodes	throughput	Normalized throughput
1	7	1.86E-1	2.02
2	19	1.69E-2	2.32
3	37	1.15E-3	2.48
4	61	5.33E-3	2.58
5	91	2.28E-3	2.61
6	127	4.41E-4	2.61
7	169	1.29E-4	2.62

FIG. 74

69/72

Level	#nodes	Throughput	Normalized throughput
2	29	2.31E-2	2.34
3	61	5.45E-3	2.51
4	101	3.01E-3	2.63
5	169	1.36E-3	2.74
6	281	5.75E-4	2.84

FIG. 75

70/72

Level	#nodes	Throughput	Normalized throughput
2	5	1.25E-1	1.78
3	13	4.20E-2	1.80
4	25	1.74E-2	2.09
5	41	8.71E-3	2.23
6	61	4.92E-3	2.30
7	85	3.00E-3	2.32
8	113	1.89E-3	2.36
9	145	1.39E-3	2.37
10	181	9.23E-4	2.38
11	221	6.90E-4	2.38
12	265	5.11E-4	2.39

FIG. 76

71/72

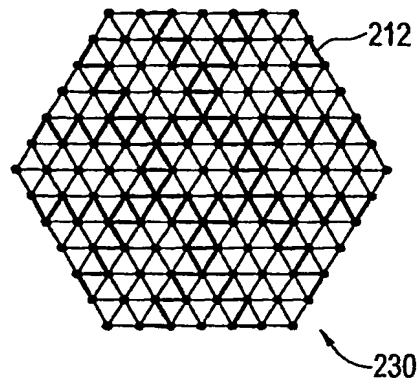


FIG. 77A

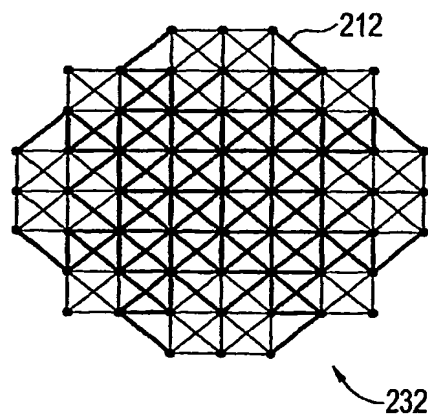


FIG. 77B

72/72

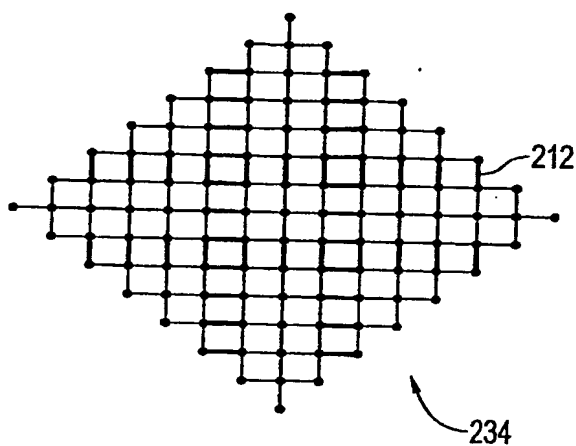


FIG. 77C